Bladensburg Concrete Bowstring Bridge
Spanning Wakatomika Creek at State Route 541
Bladensburg vicinity
Knox County
Ohio

HAER No. OH-52

PHOTOGRAPHS

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
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HISTORIC AMERICAN ENGINEERING RECORD

Bladensburg Concrete Bowstring Bridge

HAER No. OH-52

Location: State Route 541 over Wakatomika Creek, eastern limits of Bladensburg, Jackson Township, Knox County, Ohio

UTM Coordinates: 17/391350/4459930

Date of Construction: 1928

Present Owner: State of Ohio
Department of Transportation
25 South Front Street
Columbus, Ohio

Present Use: Vehicular traffic

Significance: The Bladensburg Concrete Bowstring Bridge, scheduled to be replaced within the next five years, serves as an example of the innovative and popular "concrete rainbow arch" design. Patented by well-known engineer, J. B. Marsh, the design took on increasing popularity for its practical and aesthetic qualities as it became an official design of the Ohio Department of Highways during the 1920s, an era of growing state participation in bridge building. The bridge is listed as a "selected bridge" in the Ohio Department of Transportation's Ohio Historic Bridge Inventory Evaluation and Preservation Plan.

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The Bladensburg Concrete Bowstring Bridge features structural elements of both bowstring and reinforced concrete arch bridges. This bridge consists of a concrete and steel superstructure and substructure. It has a total length of 88 feet and has an overall width of 32.5 feet. Concrete arches, measuring 30 feet from spring line to crown, flank the deck of the bridge.

The top-most point of each arch rises 11 feet from the deck. Each arch springs from concrete abutments. The deck is supported by eight concrete beams hung from the arches by eight concrete posts. A concrete balustrade runs between the ends of the arch while a solid concrete parapet with inset panels and heavy square posts sit at the ends of the deck. The deck is concrete and the roadway measures 24 feet. Steel plates provide connections between the arches where they bear on the abutments.

A skeleton of steel bars reinforces the entire structure. A patent on this design by J. B. March in 1912 enabled concrete bowstring arch bridges to better withstand tensile stresses and expansion and contraction caused by temperature through the use of a steel plate and rocker connection between the arches and abutments.[1]

James B. Marsh was born in North Lake, Wisconsin, in 1856. He moved to Iowa at age 18 and attended preparatory school at Fredericksburg. In 1882, he received a B.M.E. degree from Iowa College of Agriculture and Mechanical Arts in Ames. Marsh began his professional career in 1883 as an agent at the Des Moines office of King Bridge Company of Cleveland and patented a metal bowstring arch bridge as a result of his work. Through his work with the King Bridge Company, Marsh had strong business ties with Ohio, the state in which his design most rapidly became popular. At the same time, he headed the Northern Agency of Kansas City Bridge and Iron Company. By 1889, Marsh was appointed general western agent and contracting engineer for King Bridge.

Marsh, however, had independent ambitions and formed his own bridge company in 1896. With his own company, Marsh experimented with concrete in bridge construction. Realizing that he was in a competitive business, Marsh incorporated Marsh Bridge Company in 1904 and expanded beyond bridge building in 1909 with the formation of Marsh Engineering Company, three years before he received the concrete bowstring patent.[2] Early concrete bowstring bridges utilized concrete simply to stiffen the steel or iron member within an encasement. The concrete also protected the metal from the weather.

These bridge types originated in Europe in the late nineteenth and the early twentieth century. M. A. Considere designed the first such structure in France in 1904. The Swiss soon made further developments on the design. In these first concrete bowstring bridges, the upper chord absorbed compressive stress and the lower chord absorbed tensile stress, as in their iron and steel counterparts.

The idea of concrete bowstring bridges first took root in the United States through the introductory design of Howard M. Jones, engineer for the Cumberland River Commission. Jones designed a concrete-arch through truss without diagonals to span a railroad yard in Nashville, Tennessee. The construction of the truss above the deck prevented the bridge from interfering with rail traffic.

In Hamilton County, Ohio, the Board of Commissioners adopted the concept of concrete bowstring bridges when it replaced a bridge near Lockland in 1909. Admiring Jones' design, the commissioners decided that the concrete bowstring design was an effective method of limiting obstruction to the stream's flow during high waters. The bridge, designed by the engineering staff in the county surveyor's office, included concrete and steel hangars from which the roadway was suspended from concrete arches.[3] This bridge design became quite popular in

Hamilton County, but engineers across the county criticized the use of concrete as too complex and expensive and as insufficient for handling tensile stress[4] (see the report on the Benson Street Concrete Bowstring Bridge, HAER No. OH-50).

Nevertheless, the concrete bowstring design, as adapted by J. B. Marsh, became one of the standard designs for bridges on Ohio's inter-county highway system. The Hamilton County Board of Commissioners' satisfaction with the concrete bowstring concept became apparent throughout the state. This knowledge and practicality influenced the Ohio Department of Highways and Public Works to adopt the Marsh design, known as the concrete rainbow arch, as one of its standard designs by 1921.[5] The department desired bridges which would have lower working stresses, could handle much higher traffic loads, lower costs in form work, lower labor costs, and could handle the temperature extremes, heavy snows, and winds that are common in Ohio.[6] With the concrete rainbow arch design, state and county bridge authorities were able to by-pass the large and expensive bridge companies in favor of less costly general contractors and non-union, semi-skilled and unskilled labor. The concrete rainbow arch bridge was also attractive to state authorities because devastating floods in March 1913, in which hundreds

of Ohio bridges were lost, had impressed upon them the desirability of placing trusswork out of the paths of raging waters.

In the 1920s, Ohioans popularized the concrete rainbow arch design for its aesthetic qualities as well as its practical attributes. Motorists became fond of the bridges that looked like rainbows. This popularity greatly influenced local officials in many parts of Ohio to favor the concrete rainbow arch in their own bridge projects and when requesting the state to build bridges.

By 1926, the popularity of the concrete rainbow arch had reached Knox County. In 1926, the Knox County Board of Commissioners realized the need for a modern highway linking Martinsburg in Knox County with Walhonding in Coshocton County, and in December 1926 it asked the Ohio Director of Highways and Public Works for state funds to build the road. Included in the request were provisions for a new highway bridge on the eastern edge of Bladensburg.[7]

This move by the Knox County Commissioners reflects the trend toward road improvement which took root throughout the United States during the 1920s. The United States emerged from World War I with a greater sense of nationality. As a result, towns and counties began to reach out to

form stronger ties with neighboring areas. The war also resulted in economic expansion that ended commercial isolation. With economic growth and the disappearance of regionalism, Americans increasingly used automobiles and trucks. These factors all contributed to a movement toward improved roads and bridges, and resulted in a push for greater availability of state funds for road and bridge improvement in rural counties such as Knox.

The residents of Ohio witnessed a surge in road and bridge construction during the post-war years, which the State of Ohio had earlier pioneered in the creation of state agencies to aid in developing better transportation routes. In 1904, the Department of Highways and Public Works was created as a clearinghouse for state money allocated for inter-county highways and as an overseer of the state's canals and associated roads and bridges. The State of Ohio formed the Bureau of Bridges in 1911 to provide for the standardization of specifications for state-funded bridges.

The Knox County Board of Commissioners cooperated with those state agencies to build the inter-county highway between Martinsburg and Walhonding. That instance of cooperation furnishes an example of the early relationship and dealings between the state and county governments

during the era of phenomenal road and bridge construction in Ohio and a sketch of bureaucratic procedures sheds important light on the state's road and bridge history.

The commissioners of Knox County were specifically concerned with receiving state aid in December 1926 to improve a section of roadway between Bladensburg and the Coshocton County line. That section was to be part of the Martinsburg-Walhonding Road, designated as Inter-County Highway 443.[8] Upon receipt of the request for state aid from the commissioners, the state director of highways ordered the county surveyor to complete a survey for the proposed roadway.[9] Under contemporary law, the state agreed to pay one-half of the surveying and preliminary study costs.[10] Prior to beginning construction, the county government also had to raise one-third of the money necessary to start construction, the state supplying two-thirds of the money for the road.[11] The county also had to make necessary land purchases for the right-of-way of the five mile road.[12]

The preliminaries were completed by January 1928, and the Knox County commissioners resolved to begin construction of Inter-County Highway 443, including the Blandensburg Bridge, with the approval of the state director of highways.[13] In addition to approving the project and

authorizing the money for it, the highways director also provided engineering direction for the road, and his office awarded the contract for the highway. L.D. Kear contracted in June 1928 to build the road, the bridge at Bladensburg, and a smaller bridge at a cost of $79,963.26.[14]

Kear, a contractor from Wharton in Wyandot County, agreed to build the Bladensburg Bridge for $13,865.39.[15] By awarding the contract to a general contractor, the state government was able to specify plans for the bridge, thus by-passing large bridge companies which submitted their own plans. Large bridge companies had earned public suspicion in the early 1900s as many instances of unethical practices by the companies were revealed in Ohio's courts (see report on Forder Pratt through Truss Bridge, HAER No. OH-42). Those cases were partially responsible for greater state oversights and planning of bridge building in Ohio. This was to the disadvantage of large bridge companies because in many instances, the Bureau of Bridges began designing bridges that a general contractor could easily follow predetermined specifications for building. Kear followed plans for a fixed concrete rainbow arch bridge which were drawn by engineers of the Department of Highways and the Public Works in 1927. Those plans were especially drawn for a "bridge over Wakatomika Creek" in Knox County on Section N of Inter-County Highway 443. The

state's specifications and estimates for the bridge give details of the materials and construction of the bridge and expected costs for such a bridge during the late 1920s. Construction of the bridge required 300 cubic yards of excavation and earth backfill at an estimated cost of $600; 40 cubic yards of excavation and rock backfill at an estimated cost of $200; and 350 cubic yards of channel excavation at an estimated cost of $350. The bridge plans called for 316 cubic yards of 1:5 1/2 concrete in-place at an estimated cost of $7,584 and 69.8 cubic yards of 1:6 1/2 concrete in-place at an estimated cost of $1,326.20. Metal materials included 53,410 pounds of reinforcing steel at an estimated cost of $2,670.50, 120 pieces of 2" x 12" copper sleeves at an estimated cost of $120, 100.3 linear feet of 1:5 1/2 mix open railing at an estimated cost of $300.80, 114 linear feet of 1:5 1/2 mix solid railing at an estimated cost of $399. Other materials included 318.7 square yards of 4 inch concrete wearing surface at an estimated price of $541.79 and 196 square feet of 3/8 inch premolded expansion joint piler at an estimated cost of $58.80. The total estimated cost for the bridge was $14,251.19, including $100 for removing a bridge that already existed at the site.[16] These estimates typify the costs of construction of concrete rainbow arch bridges and concrete bridges in general in Ohio during the 1920s.

In conclusion, the concrete rainbow arch design resulted from a general trend toward practicality, a greater role for state government, and increased public awareness in bridge building. The Bladensburg Concrete Bowstring Bridge stands as a product of an era in which bridge and road building procedures in Ohio developed into the pattern known throughout the remainder of the twentieth century. It also serves as an example of an innovative and attractive architectural and engineering design.

NOTES

1 U.S., Department of Commerce Office of Pattens and Trademarks, Reinforced Arch Bridge, Patent No. 1,035,026 (1912).

2 Larry Jochims, "Rainbow Arch Bridges Add Variety to Kansas Highways," Kansas Preservation, Sept.-Oct. 1980, p. 2.

3 David A. Simmons, "Hamilton County Bridge Believed to Be First of Its Kind in Ohio," Ohio County Engineer, November 1985, p. 21.

4 Engineering News, 16 February 1911, p. 199.

5 Ohio Department of Transportation, The Ohio Historic Bridge Inventory Evaluation and Preservation Plan (Columbus: Ohio Dept. of Transportation, 1983), p. 242.

6 Carl W. Condit, American Building Art: The Twentieth Century (New York: Oxford U. Press, 1961), p. 195.

7 Ohio, County of Knox, Board of Commissioners, Commissioners Journal (1926).

8 Ibid. (1928).

9 Ibid. (1926).

10 Ibid. (1926).

11 Ibid. (1927).

12 Ibid. (1928).

13 Ibid. (1928).

14 Highways Division Contract No. 3576, 3 February 1928. Director's Journal and Index of Contracts Let, 1906-1978, Ohio Department of Transportation Archives, Ohio Historical Society, Columbus, Ohio.

15 Bridge Reports, 1926-1929, Deputy Director's Correspondence, 1919-1929, and 1967-1969, Dept. of Highways Administrative Files, Ohio Department of Transportation Archives, Ohio Historical Society, Columbus, Ohio.

16 Ohio, County of Knox, Board of Commissioners, Commissioners Journal (1928).

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